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Chairman Weber, Ranking Member Grayson, and Subcommittee Members, thank you for the opportunity to testify today.

My name is Ruth McCormick, and I am the Director of Federal and State Affairs for the Business Council for Sustainable Energy.

The Council is a broad-based industry trade group representing companies and associations in the energy efficiency, natural gas and renewable energy industries. Its membership includes independent electric power producers, investor-owned utilities, public power, commercial end-users, equipment manufacturers, project developers as well as service providers for energy and environmental markets. Since 1992, the Council has been a leading industry voice advocating for policies at the state, national and international levels that increase the use of commercially-available clean energy technologies, products and services.

I have been asked to address the Council's view about the value of the research, development, demonstration, deployment (RDD&D) and commercialization activities funded through the Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) and the impact of DOE's clean energy technology programs, including those at EERE, on the energy marketplace. This subcommittee has a significant role to play in overseeing the country's strategic energy investments, which have contributed to the development and deployment of highly valuable energy technologies and resources that underpin the United States economy.

Over the past several years, the United States has seen real market penetration of a wide range of sustainable energy technologies and resources and we have witnessed the results of policies that work. But there is more work to be done.

To continue to the momentum of growth in these sectors, and to receive their co-benefits, long-term, stable polices will be needed to level the playing field and to provide market access to new technologies. We also need continued investment in energy research, development and deployment to increase the efficiency of our energy generation and use, and to spur new innovations. This is important for domestic economic growth and for U.S. competitiveness in global energy markets.

I would like to focus my testimony on two areas. First, I would like to share some of the findings from the 2015 edition of the *Sustainable Energy in America Factbook*.[1] The *Factbook* was researched and produced by Bloomberg New Energy Finance and commissioned by the Business Council for Sustainable Energy. It is a quantitative and objective report, intended to be a resource for policymakers with up to date, accurate market information. Its goal is to offer important benchmarks on the contributions that sustainable energy technologies are making in the United States energy system today. It also provides information on finance and investment trends in clean energy resources.

The second area I would like to discuss is the valuable and effective role that federal government investments in the energy sector have played, and should continue to play, in the availability of new, innovative energy technologies and practices. These investments in the form of research, development and deployment initiatives as well as federal tax incentives have expanded the energy technologies and resources available for the nation, while helping to lower energy costs for businesses and consumers, and create hundreds of thousands of jobs in the United States. As a neutral player, rather than one with a financial interest, DOE can help analyze policy options for deploying new energy technologies and their potential impacts on the grid. In addition, DOE can help streamline the processes of permitting, inspection, and interconnection of new energy technologies. DOE should continue to dedicate resources and increase prioritization of this effort.

Sustainable Energy in America Factbook Findings

Some of the most significant findings from the *Sustainable Energy in America Factbook* point to the dramatic changes underway in the United States energy sector over the past several years. Traditional energy sources are declining, while natural gas, renewable energy, and energy efficiency are playing a larger role.

These changes are increasing the diversity of the country's energy mix, improving our energy security, cutting energy waste, increasing our energy productivity and reducing air pollution and greenhouse gas emissions.

Behind this change are a portfolio of new energy innovations, technologies, and applications. These include: newly applied techniques for extracting natural gas from shale rock formations; lower-cost and higher-efficiency photovoltaic panels for converting sunlight to electrons; highly efficient, natural gas end-use applications; natural gas vehicles and battery and fuel cell electric vehicles; and 'smart meters' that allow consumers to monitor, modulate, and cut electricity consumption, among others.

[1] 2015 edition of *the Sustainable Energy in America 2013 Factbook,* February 2015, http://www.bcse.org/sustainableenergyfactbook

The *Factbook* looks at a broad spectrum of sustainable energy technologies and provides data on a wide range of clean energy industries including natural gas, renewable energy sources (including solar, wind, hydropower, geothermal, biomass, biogas and waste to energy – but excluding liquid biofuels), stationary fuel cells and other distributed technologies, as well as energy efficiency.

The *Factbook* also aims to fill data gaps. For example, data sources and economic models of the United States energy industry often fail to capture the full contribution of sectors such as distributed generation. The *Factbook* seeks to accurately quantify some sectors that are currently small, but growing.

Recent Changes in the U.S. Energy Sector

The United States economy is becoming more energy productive and less energy intensive. By one measure—United States gross domestic product (GDP) per unit of energy consumed—productivity has increased by 54% since 1990. Between 2007 and 2014, total energy use fell 2.4%, while GDP grew 8%. This was driven largely by advances in energy efficiency in the transportation, power generation and buildings sectors.

While energy demand has fallen more steeply than it has in at least 50 years, the use of natural gas and renewable energy has increased. Natural gas provided the United States with 28% of its total energy supply in 2014, and renewable energy is supplying 9.7% of U.S. energy. Natural gas-fired power plants provided 27% of U.S. electricity in 2014, up from just 22% in 2007. Renewable energy generation has meanwhile grown from 8.3% to 12.9% between 2007 and 2014.

The United States energy sector is witnessing structural changes in its infrastructure that reflect its low-carbon transformation: the retirement of high-emissions power plants, the build-out of new natural gas pipelines, advances in a smarter grid, and growing interest in distributed generation from rooftop photovoltaics, fuel cells and combined heat and power (CHP).

The commercial and industrial sector is demonstrating a continued appetite for CHP (about 700 megawatts (MW) per year since 2009) as well as interest in microgrids.

Market Dynamics

The cost to deploy many clean energy technologies is falling while new business models for financing and technology innovation are accelerating deployment.

The technology innovations in the natural gas sector that have opened up new supply from shale gas production have lowered natural gas prices and have resulted in 2014 being a record year for both natural gas production, which has increased by 25% since 2007, and consumption.

The United States economy is becoming more energy-productive and less energy intensive—with efficiency improvements in buildings, and transportation breaking new ground. Smart

meters have been deployed to 39% of electricity consumers, increasing their ability to make decisions on when and how to use energy.

Renewable energy is a prominent part of the United States capacity mix, with 205 gigawatts (GW) installed across the country. For example, wind and solar have more than tripled in capacity since 2008. Hydropower is the largest source of the United States' renewable energy at 79 GW (excluding pumped storage). Biogas, biomass, geothermal and waste-to-energy, represent 17 GW of capacity in the United States and can provide power 24/7. While these technologies have comparable economics in terms of unsubsidized costs, they have lacked access to the same incentives as the fast-growing sectors.

The Impact of Policy on Renewable Energy and Energy Efficiency Growth

Stable, long-term policies at state and federal levels that provide a level playing field and enable market access, combined with targeted investments in research, development and deployment, are needed to sustain the growth in clean energy sectors.

Though the levelized costs of electricity of many renewable generation technologies have fallen drastically, most of these technologies still rely on incentives to compete. State-level mandates have been important drivers for renewable growth in the United States, though in the case of most states, targets for the next several years have already been satisfied and uptake in energy efficiency policies has been slowing.

DOE works to address market barriers to the adoption of new technologies that are market ready – such as a lack of reliable information, inconsistent regulatory environments, and workforce training gaps – through activities that include providing best practice information, stakeholder outreach, sustaining and enhancing the clean energy workforce and providing reliable, objective data. These efforts can help these technologies to the edge of widespread market adoption and should be continued.

Grid Modernization, Reliability and Resiliency

Ensuring ongoing grid reliability will become a growing concern for electricity market operators and regulators. Dynamics contributing to this focus include declines in the use of coal, the impacts of severe weather events and the increased presence of variable energy resources on the electricity grid. Yet other changes are occurring – including reduced electricity demand through energy efficiency; the introduction of smart grid technologies for improved grid management; and the growing role for distributed generation from stationary fuel cells and other technologies for back up or base load power, as well as dispatchable resources such as natural gas plants, hydropower, and demand response – that can help the electricity industry meet these challenges. Still, many market structures do not yet fully recognize the benefits of some of the technologies offering increased flexibility, such as energy storage.

Given these factors, research, development and deployment (RD&D) investments are needed in this area to improve efficiency, demonstrate performance and spur new innovations that will be required to meet the evolving needs of the power grid. For example, investment being made in smarter and more efficient technologies such as voltage sensors can help utilities better pinpoint what is happening on the grid and speed power restoration efforts when outages occur.

Federal Investments in Research, Development and Deployment Foster U.S. Competitiveness, Energy Security

BCSE strongly supports the continued funding of basic and applied research and development for clean energy technologies. This must be balanced with work on commercialization, market transformation and other efforts to ensure that products do not sit on laboratory or university shelves, but are transferred to the private sector to achieve the intended public benefit of the research and development.

While DOE is primarily a research and development institution, it is uniquely positioned to address barriers in the marketplace that inhibit the successful deployment of clean energy technologies and should dedicate significant resources to these market efforts, especially for technologies that are ready to progress out of the "innovators" area of the technology adoption cycle and into "early majority" stage.

There are strong analytical findings that show the overall return on investment that has resulted in federal energy RD&D investments. This jump starts private sector innovation, which is critical to our long-term economic growth, energy security, and international competitiveness. DOE has supported effective programs, many in partnership with the private sector, that have resulted in the availability of new, more efficient energy technologies.

DOE's programs are helping to drive new investments and the United States has become one of the most attractive markets in the world for companies whose operations entail significant energy-related costs. At 6.87¢/kWh, the retail price of electricity for the industrial sector in the United States is lower than that in other major economies, such as Europe, China and Mexico.

In our current constrained budgetary environment, support for energy RD&D might be questioned. In response, I would argue that the energy sector, like the transportation sector for example, involves technologies that have been transformed over the course of a century. Just as the government should not stop investing in automotive research & development (R&D) – improving fuel efficiency and economy, safety, incorporating new materials, etc., it is critical that the federal government continue to investment in advancements in the energy sector.

Sustainable Energy RD&D Investments

Natural Gas

The technological advances allowing for the low cost extraction of natural gas from shale occurred due to more than three decades of federal government investment in research, demonstration, and production. According to a 2011 Breakthrough Institute report, both directly and indirectly, the government supported critical moments and tools in the shale gas revolution – massive hydraulic fracking (MHF), 3-D mapping, horizontal drilling, and horizontal wells.[2] This technological advancement offers the potential for stable natural gas prices in the $4 to $6 MMBtu range.[3] At these price ranges, natural gas has the potential to provide an abundant, clean and domestic fuel source for direct use applications, transportation and power generation.

Related to this, DOE should consider undertaking more RD&D into efficient natural gas technology, ensuring that businesses and consumers utilize natural gas wisely and efficiently. Specific technology areas for increased focus would include: fuel cells, micro combined heat and power, natural gas fired cooling and heat pumps, solar/gas hybrid systems, and natural gas vehicles.

Further, in 2011, the American Gas Association, Gas Technology Institute and Navigant consulting released a white paper that offered a vision of a smart energy infrastructure integrating natural gas with electricity from multiple sources, including renewable energy. To achieve this vision, several RD&D areas were recommended. I note a few below.

- Include natural gas in advanced metering infrastructure development to optimize common infrastructure, interoperability and cross-compensation among all utility infrastructures including electricity and water;
- Ensure that future federal funding programs including Smart Grid encourage and allow the use of funding for dedicated natural gas projects and combined electric/natural gas projects; and
- Increase governmental funding for basic as well as applied research in natural gas safety and reliability and smart energy infrastructure technology.[4]

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[2] *Where the Shale Gas Revolution Came From: Government's Role in the Development of Hydraulic Fracturing in Shale,* Michael Shellenberger, Ted Nordhaus, Alex Trembath, Jesse Jenkins, Breakthrough Institute, May 23, 2012. http://thebreakthrough.org/index.php/programs/energy-and-climate/where-the-shale-gas-revolution-came-from

[3] *Rethinking Natural Gas, A Future for Natural Gas in the U.S. Economy,* p. 6 , American Gas Association, © 2012, citing Source: Wood MacKenzie Spring 2012.

[4] *Natural Gas in a Smart Energy Future*, Gas Technology Institute, Navigant. January 26, 2011. http://www.gasfoundation.org/ResearchStudies/natural-gas-smart-energy-future.htm

Hydropower

The DOE Water Power Program is growing the nation's global position by funding cutting-edge research to produce the next generation of conventional hydropower and marine and hydrokinetic (MHK) technologies, and by accelerating the development of markets for those technologies. The main objectives of the Water Power Program are to improve hydropower technologies and to gather critical industry, operational and environmental impact data.

Currently, the conventional hydropower industry employs more than 300,000 workers in the United States, making it the largest renewable electricity production workforce in the nation. With the Water Power Program's goal for water power technologies to provide 15% of the nation's energy by 2030, hydropower can provide hundreds of thousands of new jobs and economic development benefits for communities.[5]

Further, increasing hydropower generation provides more clean energy megawatts to the grid, and also increases the amount of grid reliability, stability and integrations services to enhance the penetration of variable energy resources. While hydropower and pumped storage projects can provide regional and grid-scale energy storage and other ancillary services, doing so will require projects to operate in new ways and modes, and in some cases, utilize new technologies. This makes continued federal research investments vitally important.

Energy Efficiency

Policy measures have helped further the cause of energy efficiency and DOE's efficiency programs have resulted in exceptional value for American consumers and businesses, yielding benefits far beyond their nominal outlays. These programs have retrofitted over 450,000 homes in 43 states, dramatically improved the efficiency of household appliances such as refrigerators and clothes washers, and improved the quality of commercial and residential buildings across the country.[6]

On February 7, 2013, the Commission on National Energy Efficiency Policy, convened by the Alliance to Save Energy released at its Energy2030 vision. The Commission's report includes a goal of doubling energy productivity in the United States by 2030 and a set of recommendations to achieve this goal, which includes continued support of energy productivity RD&D. Achieving the goal could save $327 billion annually and add 1.3 million jobs.[7]

The Commission noted that private R&D budgets are limited in many energy efficiency sectors. Market barriers also prevent adoption and commercialization of new innovations. Thus

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[5] *Water Power for a Clean Energy Future*, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy,
http://www1.eere.energy.gov/water/pdfs/wp_accomplishments_brochure.pdf

[6] Alliance to Save Energy at http://www.ase.org/advocacy/immediate-action-needed-defend-federal-energy-efficiency-programs

[7] *Energy2030: Doubling U.S. Energy Productivity by 2030*, http://ase.org/programs/ee-commission

government support both for R&D and for a wide range of deployment programs has been critical to advances in energy productivity. Looking forward, the Commission recommends increased federal investment in basic and applied research, development, demonstration, deployment, and technical assistance at DOE, the Environmental Protection Agency, and other federal agencies. The federal government should also encourage private R&D through other policy approaches such as public-private consortia, the R&D tax credit, and supporting challenges or contests.

Building envelope assemblies including, insulating materials and air-sealing system technologies are essential to improving building efficiency. To enable mass market adoption, these next-generation technologies must maintain or improve building enclosure durability, including moisture, fire, indoor air quality, acoustic, and structural performance requirements. In the case of retrofitting existing buildings, the installation must be fast and easy so that there is minimal impact on building occupants. BCSE believes DOE should focus additional efforts to accelerate, and improve, building energy performance.

Fuel Cells

Fuel cells are a unique set of clean, efficient, and resilient energy technologies for stationary power generation, backup power, material handling equipment, and motor vehicles. Fuel cells generate electricity electrochemically, and therefore are more efficient than traditional power-generation technologies.

The industry continues to see progress in all sectors. For example, the largest stationary fuel cell project in the country was placed in service at a major utility last year. This news was followed a by series of high-profile announcements by Fortune 500 companies choosing fuel cells for their power needs, both for the positive environmental impact, and because they make a real difference on a company's bottom line.

Furthermore, warehouses and other logistic-based businesses continue to acquire fuel cell forklifts and material handling equipment to replace traditional platforms. The transition has helped businesses streamline operations, improve productivity, and make better use of warehouse space.

Automobile companies including Toyota, Hyundai, Honda, General Motors Daimler, Nissan, and BMW have invested billions of dollars in fuel cell technology, resulting in a new generation of electric vehicles that completely replicate the driving experience of today's vehicle technology. By 2016 three automobile manufacturers will offer FCEVs for sale in United States showrooms.

We also encourage DOE to expand their existing efforts to move the technology out of the laboratory and into the market place. The Department should build off of the success it enjoyed to introduce fuel cell technology in the material handling sector by leveraging state activities to encourage stationary fuel cells and hydrogen infrastructure to support fuel cell electric vehicles. This will help improve overall resiliency and continue to reduce carbon emissions from transportation.

Solar

The cost of solar photovoltaic (PV) modules has fallen more than 80% since 2007. The United States installed 6,201 megawatts (MW) of solar PV in 2014 and 767 MW of concentrating solar power to reach 20 gigawatts (GW) of total installed capacity, enough to power 4 million American homes. 32 percent of new electric generating capacity came from solar in 2014, and the industry now employs nearly 175,000 workers, more than tech giants Google, Apple, Facebook and Twitter combined.[8] This development and these lower costs can be attributed to the Investment Tax Credit and smart investments in R&D at DOE and national laboratories over the last four decades.

While solar hardware costs have fallen significantly, however, market barriers and grid integration challenges continue to hinder greater deployment. Non-hardware "soft costs," such as permitting, financing and customer acquisition, are becoming an increasingly large fraction of the total cost of a solar system. DOE can help to streamline the processes of permitting, inspection, and interconnection of solar systems. As a neutral player, rather than one with a financial interest, DOE can help analyze policy options for deploying solar and their potential impacts on the grid. EERE should continue to dedicate resources and increase prioritization of this effort.

Some are of the opinion that DOE's mission stops at the laboratory bench. This is a fallacy that if brought to fruition would leave technologies unable to cross the chasm to commercialization. We need engineering and economic expertise at DOE to complement physics and chemistry.

Wind

Past investments in wind have resulted in significant improvements over the past 30 years, such as increased output, improved reliability, and lower costs. In fact, between 2007 and 2014 the cost of wind dropped more than 27%; In 2014, wind developers secured power purchase agreements (PPAs) with utilities below the levelized cost of electricity (in $20-30/MWh) range for fossil-fired power and below the price of wholesale power in the Midwest, Southwest, and Texas.

The wind industry has done more than any other energy industry to study and address impacts to birds and other wildlife. In this spirit, the industry is requesting clarifying language in the budget for the Wind Energy Program. $9.5 million of the Administration's FY2016 DOE budget request is directed to assist in funding research designed to understand the potential impacts of wind energy development and operations on wildlife and to develop practical technology-based solutions to avoid and reduce those impacts. The industry requests that $4.5 million within the DOE Wind Energy Program budget be spent on a research initiative to develop and evaluate advanced mitigation technologies to better understand and minimize wind energy project impacts on eagles. This funding would also support wind industry efforts in obtaining new

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[8] *U.S. Solar Market Insight: Q3 2014*, http://www.seia.org/research-resources/us-solar-market-insight

permits required by the Bald and Golden Eagle Protection Act. The industry is also requesting that $5 million within the Wind Energy Program be used for expanding ongoing work to understand and develop mitigation measures to reduce the impact of wind projects on bird and bat populations.

Information and Communications Technology Infrastructure

In an increasingly complex energy system, Information and Communications Technology (ICT) can be used to improve the reliability, resiliency and efficiency of the grid's transmission, storage and distribution infrastructure, and to help reduce pollutant emissions through better real time monitoring and control of grid systems. Further ICT applications to enhance end-use energy efficiency and facilitate demand response strengthen grid efficiency and reliability by reducing peak load stresses and line losses and by allowing better grid management in case of generation outages or transmission anomalies.

In the past, transmission, storage and delivery in the energy grid historically was a relatively straightforward, linear system of generation to transmission to distribution. Dispatching was generally local and based on marginal cost considerations. Margins of safety were large because of limited real-time information and limited options for replacement of power generation sources in an emergency.

Today's grid must adapt to emerging challenges and opportunities – fluctuating energy prices, an increasingly transactive role for customers, integration of distributed energy resources, the need for improved resilience, and the need to reduce greenhouse gas emissions. In order to meet these challenges, a vastly increased role for ICT is essential. Without continually enhanced ICT in the TS&D infrastructure, the grid cannot achieve these 21st century goals. ICT will allow real-time monitoring of actual conditions throughout the system, and provide the ability to control TS&D system functions so as to maximize efficiencies and ensure reliability with less additional costly excess capacity.

Studies have shown grid-related investment in ICT provides enormous benefits for energy efficiency, economic growth and maximum use of non-polluting energy sources.

Conclusion

The *Sustainable Energy in America Factbook* shows that with a mix of research, development and deployment initiatives supported by policies and incentives at the state and federal level, the United States has experienced a rise in market penetration of a broad range of sustainable energy technologies. The data shows that the policies that have been adopted have worked but the work is not done. To ensure secure, clean, reliable, affordable energy sources in the United States we must continue the federal government's partnership in research, development and deployment programs. Council members have specific views on programs that have been

effective for their industries and look forward to working with this Committee to identify effective programs that bring a strong rate of return to tax payers while unlocking the vast domestic potential for sustainable energy technologies.